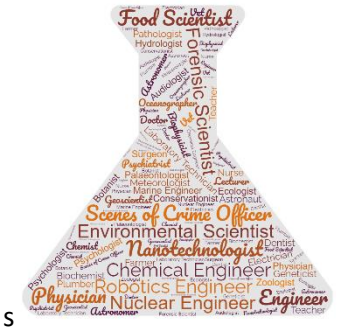
Science



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Intent

As pupils begin their scientific journey with us at Longthorpe Primary School, they come with a natural curiosity about the world and phenomena around them. Therefore, a core aim of our science curriculum is to build on this by celebrating and developing pupils' inquisitive minds. Through our curriculum's wide range of purposeful, planned and structured learning opportunities, pupils will gain a solid understanding of scientific processes, the scientific method and an understanding of the purpose and implications of the three core disciplines of science: biology, chemistry and physics. It is our intent that pupils will begin to understand how these disciplines link to their daily lives, the different stages of their education and through their future life experiences. We also think it is important for pupils to see themselves reflected in the science curriculum, by highlighting present-day role models and the contributions of scientists from a wide range of backgrounds. It is our aim that all pupils will transition to year 7 with a solid set of scientific skills and knowledge alongside the strong sense of awe and wonder that they began school with, setting them up successfully to be the scientists of tomorrow.

Our science curriculum has been chosen because it promotes the structured acquisition of substantive scientific knowledge based on Wynne Harlen's 'Big Ideas of Science Education'. These ideas are weaved through the curriculum as 'vertical concepts' that, when understood together, allow pupils to begin comprehend the complex world around them. Our curriculum has been deliberately designed for pupils to master substantive knowledge by:

- Ensuring pupils master core content through the development of key concepts and the timely revisiting of key knowledge.
- Sequencing the curriculum and selecting knowledge to allow for gradual development of our vertical concepts – the 'Big Ideas' in science – to provide firm foundations for KS3.
- Preventing common misconceptions that are often formed at an early age and prove problematic at the later stages of pupils' science education.
- Purposefully teaching appropriate knowledge that goes beyond the KS1 and KS2 national curriculum, to aid current and future understanding, and to smooth the transition to KS3.
- Encouraging pupils make connections between the disciplines of science, the wider curriculum and the wider world.

Vertical Concepts – the 'Big Ideas'			
1. All material in the Universe is made of very small particles.	2. Objects can affect each other at a distance.	3. Changing the movement of an object requires a net force acting on it.	4. The total amount of energy in the Universe is always the same but energy can be transformed when things change or are made to happen.
5. The composition of Earth and its atmosphere and the processes occurring within them shape the Earth's surface and its climate.	6. The solar system is a very small part of one of millions of galaxies in the Universe.	7. Organisms are organised on a cellular basis.	8. Organisms require a supply of energy and materials for which they are often dependent on or in competition with other organisms.

9. Genetic information is passed down from one generation of organisms to another.	10. The diversity of organisms, living and extinct, is the result of evolution.	11. Organisms are healthy when physically, mentally and socially well and free from disease.

Our curriculum has also been designed to teach our pupils to 'think as scientists' and work scientifically. The **Working Scientifically** elements of the science curriculum have been mapped out throughout each year group to ensure pupils have many opportunities to apply their scientific skills. The curriculum has been sequenced so that the content is reviewed in subsequent units (and is also reviewed in other subject areas). This is achieved by:

- Sequencing **Working Scientifically** elements so that they are explicitly taught and practised alongside the substantive knowledge, and regularly reviewed and built upon across the years and key stages.
- Making deliberate and explicit links to other curriculum areas – particularly geography and mathematics – to ensure there is a consistent approach to teaching content.
- Planning practical tasks that have a clear purpose: to demonstrate or prove substantive concepts, or to allow pupils to deliberately practice working scientifically skills in a relevant context.

	Working Scientifically Elements			
	Scientific Attitudes & Planning	**Measuring & Observing**	**Recording & Presenting**	**Analysing & Evaluating**
EYFS	Make predictions about what might happen when I try something.	Measure/observe using senses. Observe using a magnifying glass safely.	Use hoops to classify objects based on simple criteria.	Notice patterns in the world around me.
Year 1	Scientists look for patterns in the world around them. Scientists group objects or living things based on their properties.	Gather information from text/ books/ images.	Record numerical or descriptive observations in a table. Draw a diagram, a simple scientific drawing that explains or informs. Use a table to classify items based on properties.	Make simple statements about the results of an enquiry.

	Scientists conduct secondary research to learn from what other scientists have already learned.		Use a Carroll diagram to classify items based on properties. Use a Venn diagram to classify items into two or three sets based on properties.	
Year 2	It is important that we keep as much as we can the same, apart from the one thing we measure and the one thing we change. Make a prediction based on substantive knowledge. There are four main stages of enquiry (A&P, M&O, R&P, A&E). Scientists identify potential hazards in their experiments and plan ways to reduce them.	Make systematic observations of an object.	Use a pair of axes to classify items based on the extent it displays two properties.	Ask further questions that could be explored to extend findings.
Year 3	Select most appropriate equipment to measure (the variables) that will give you the best chance of an accurate result. A dependent variable is what you measure; an independent variable is what you change; controlled variables are things that stay the same. Scientists identify factors in an investigation that should be controlled, and try to find ways to control them. Write an appropriate method. Science is studied as three disciplines: biology (study of organisms), chemistry (study of materials) and physics (study of energy).	Gather information from the internet. Anomalous results should be discarded and rerecorded. Data is repeatable if the same person repeats the investigation and gets the same results; data is reproducible if the investigation is repeated by a different person and the results are the same. Taking multiple readings allows you to see if your data is repeatable, and helps identify outliers.	Design a table to collect data with the appropriate number of rows and columns and correct headings.	Draw conclusions (e.g. 'the greater the… , the greater the…'). Use scientific understanding to explain their findings. Suggest ways to improve practical procedures to obtain more accurate measurements. Use findings of investigation to make further predictions.
Year 4	Set a hypothesis to test. Draw diagram of the investigation.	Gather information using a data logger (e.g. sound meter app; heart rate app).	Use a classification key to identify an object.	Identify scientific evidence that has been used to support or refute ideas.

	Scientists use models to help explain their ideas.		Draw a dichotomous classification key to help others identify an object. Drawings can be labelled and annotated Present information orally using a prop or demonstration. Present information in a written format. Draw labelled and annotated diagrams.	
Year 5	Science is studied as three disciplines: biology (study of organisms), chemistry (study of properties of matter and how it interacts with energy) and physics (study of energy). Scientists look for patterns in data to try to identify correlations.	Measure force using a Newtonmeter.	Scatter graphs can help you decide if there is a relationship between two variables. (Geography: Interpret and construct climate graph). Line graphs can be used when data is continuous; bar charts can be used when data is discrete.	Make judgements on the accuracy of the data Some people may agree or disagree with the use of some scientific discoveries. Science is never 'complete' and scientists are always working to make models more accurate or to discover new explanations.
Year 6		Taking multiple readings allows you to see if your data is repeatable, helps identify outliers and allows a mean to be calculated.	Decide which graph is most appropriate for the enquiry.	Calculating the mean can be used as a method of analysing data.

Implementation

Science is taught each week and deliberately given extended time to ensure that the curriculum can be explored in depth by our pupils. A range of teaching and learning strategies are used in science to keep all pupils engaged and to teach and inspire them to want to investigate the world around them in different ways, such as: group discussions, delivering presentations, watching and taking part in demonstrations, engaging with various media content, practical explanations, and experiments, pupil-led instruction and investigative work.

The use of subject-specific vocabulary is a key part of our science lessons and is expected to be used in both oral and written work by our pupils. The key tier 2 terms (below) are used frequently alongside the teaching of science-specific tier 3 specific words which are highlighted in the Progression of Knowledge and Skills section later in this overview.

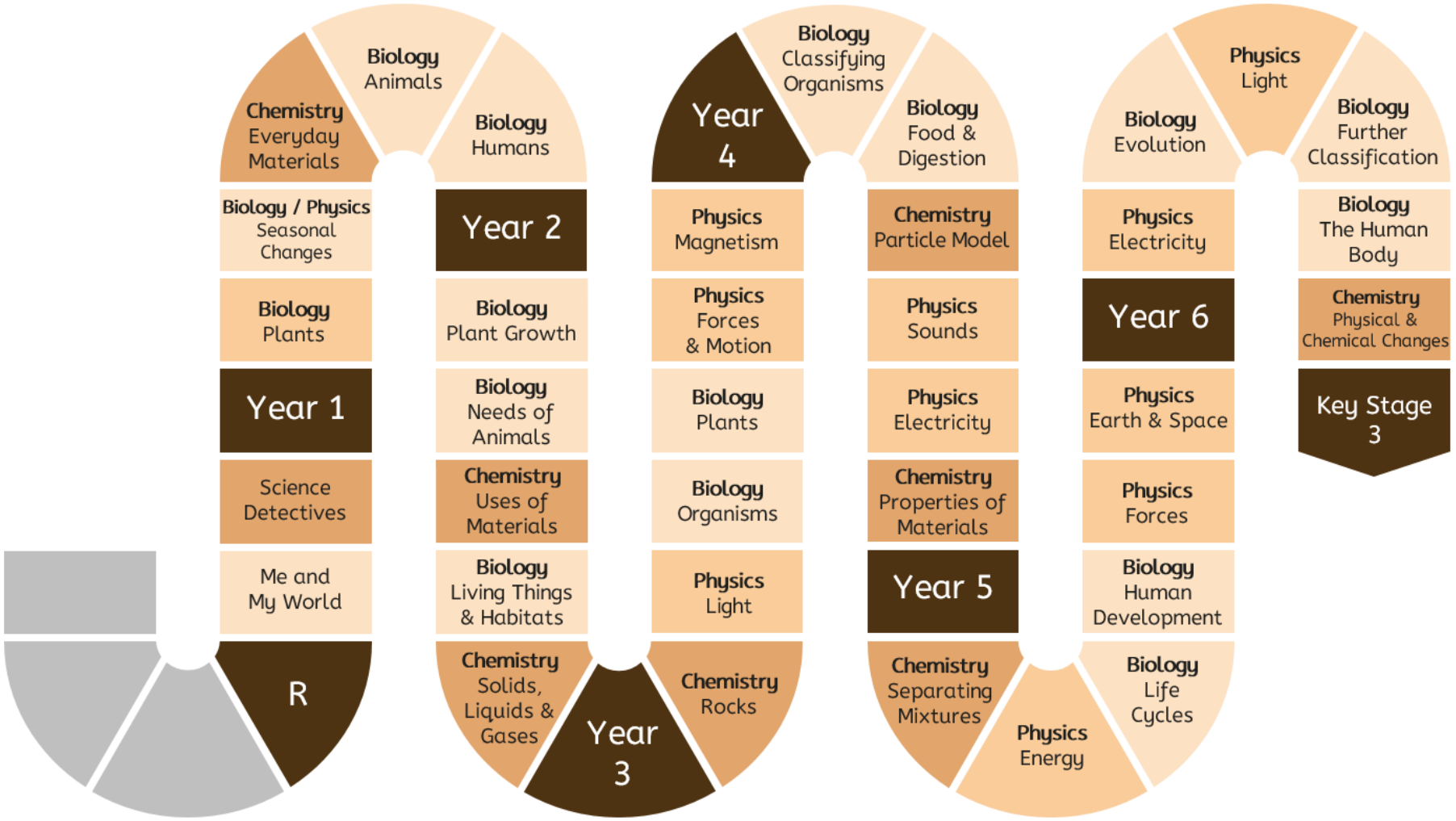
enquire	discuss	locate	observe	plan
select	measure	record	analyse	communicate

Lessons incorporate many practical, collaborative and investigative activities which ensure that pupils are able to be full participants in their learning and apply the 'working scientifically' skills they have learned. Pupils are also expected to record their learning in a range of appropriate formats that may include: written accounts including instructions, reports and explanations, illustrations, annotated diagrams, spreadsheets (data collection), charts, graphs and tables.

The Journey of a Scientist at Longthorpe

EYFS	By the end of the EYFS, pupils will have experienced science in many forms in their classroom environment. Primarily through specific learning associated with environmental science and forces and motion linked to the Early Learning Goal of 'The Natural World', however science will also have been encountered as part of the ELG of 'Managing Self' where pupils explore hygiene and healthcare and the ELG 'Creating with Materials' where pupils explore materials and processes. In both the outdoor and indoor learning areas there are opportunities for both pupil-led and teacher directed exploratory play. The pupils are encouraged to follow their curiosity, explore using their senses, observe, predict, investigate and be creative when following their natural inquisitiveness.
KS1	By the end of KS1, pupils will begin to recognise how to develop their skills, knowledge and understanding through a range of scientific investigations, where pupils work individually, in pairs or in groups. By the end of the KS1, pupils will be able to convey their knowledge of processes associated with science, apply knowledge to understand the world around them, understand methods of scientific enquiries, predict some outcomes of scientific enquiries, understand some different variables when conducting scientific enquiries, know some current uses of science, retain and recall scientific vocabulary and record an analyse simple data.
KS2	By the end of KS2, pupils will be able to apply their skills, knowledge and understanding through a greater range of scientific experiments, where pupils work individually, in pairs or in groups. By the end of KS2, pupils will be able to develop their knowledge and understanding of processes associated with biology, chemistry and physics, understand and apply methods of scientific investigation, predict the outcomes of scientific enquiries, understand the different variables when conducting scientific enquiries, convey a sound knowledge of fair testing, know current uses of science and consider future implications, retain and recall scientific vocabulary, record and analyse data in a variety of ways.

Units Overview



Progression of Knowledge and Skills

	Autumn 1	Autumn 2	Spring 1	Spring 2	Summer 1	Summer 2
Year R				**Spring in our step** Wildlife and weather in spring and winter; habitats around our school		**Science detectives** Properties of materials and habitats around the world
				Substantive knowledge: Identify the differences in wildlife that we see and the weather patterns in spring and winter. Identify a range of animals, including insects and spiders that live in habitats around the school. Explore, make observations, and ask questions about the natural world, gaining a developing understanding of important processes and changes they observe. Insects like ants, bees, and ladybirds are animals. Spiders and insects live in the habitats around our school. Some plants have flowers.		**Substantive knowledge:** Describe what they see, hear and feel when exploring forces and materials. Talk about changes they observe e.g. melting and freezing, cooking. Fruits like apples, bananas, peaches and oranges have skins, flesh and seeds. Use accurate vocabulary to describe the properties of materials and talk about forces they have experienced. **Disciplinary knowledge:** A&P: Make predictions about what might happen when I try something.

				Disciplinary knowledge: A&P: Make predictions about what might happen when I try something. M&O: Measure/observe using senses. Observe using a magnifying glass safely. R&P: Use hoops to classify objects based on simple criteria. A&E: Notice patterns in the world around me. **Vertical Concepts:** 5B: We experience different types of weather in different seasons (focus on spring and winter).		M&O: Measure/observe using senses. R&P: Use hoops to classify objects based on simple criteria. A&E: Notice patterns in the world around me.
Year 1	**BIOLOGY** **Plants** Identifying and naming common plants and describing basic structures	**BIOLOGY / PHYSICS** **Seasonal changes** Observing changes across four seasons and describing associated weather	**CHEMISTRY** **Everyday materials** Distinguishing objects from their material, and describing simple properties	**Consolidation and review**	**BIOLOGY** **Animals** Naming reptiles, fish, amphibians, birds and mammals; carnivores, herbivores, omnivores	**BIOLOGY** **Humans** Human body parts and senses
	Substantive knowledge: A **plant** is a **living** thing that usually grows in one place. **Coniferous** plants keep their leaves all year round (e.g. pine, yew, juniper in UK). **Deciduous** plants lose their leaves in winter (e.g.	**Substantive knowledge:** **Weather** is a description of what the conditions are like in a particular place. Examples of weather include sunny, rainy, windy, warm, cold, cloudy, drizzle, snow, stormy (with thunder and lightning).	**Substantive knowledge:** An **object** is a 'thing' that can be seen and touched. Objects have a name and often have a **purpose.** For example, a cup is the object, and its purpose is for drinking from. The **material** is what an object is made of, for		**Substantive knowledge:** **Animals** are different to **plants** because they usually move around, rather than stay in the same place. Animals can be placed into different groups (**carnivores**, **herbivores**	**Substantive knowledge:** Humans are **omnivores**, but some choose to eat only plants. Humans are made of many different body parts including head, neck, back, ears, eyes,

	oak, silver birch, horse chestnut, sycamore, ash). **Trees** are a type of plant that have a tall **stem** made of **wood.** The basic parts of a plant are **leaves**, **flowers**, **roots**, **stem/trunk/branch.** **Disciplinary knowledge:** ***Draw and label a scientific diagram of a plant*** R&P: Draw a diagram, a simple scientific drawing that explains or informs. ***Classify trees as deciduous or coniferous using images of them at different times in the year*** R&P: Use a table to classify items based on properties **Vertical Concepts:** 5A: Some plants grow in soil. 7: Plants are organised with roots, stem, leaves and flowers.	The weather can change rapidly in one day (e.g. sunny morning and rainy afternoon). The UK and our local area have daily weather patterns. **Extreme weather** is very different from the weather that you would usually expect to see in the country. There are four **seasons**: **spring**, **summer**, **autumn** and **winter.** The **weather** changes gradually as we move from season to season. Recognise differences between four seasons in terms of living things (trees lose leaves; flowers drop and we see different animals, such as butterflies in the summer). **Daytime** is when the **Earth** is facing the **Sun**; nighttime is when the Earth is facing away from the Sun. In the **summer** that there are more hours of **daylight** and in **winter** there are fewer hours of daylight. The **Moon** is more visible at night. **Disciplinary knowledge:** ***Conduct geographical /scientific fieldwork and observe/collect data about the weather.***	example a cup can be made of paper or plastic. Common materials include **wood**, **paper**, **metal**, **glass**, **plastic, water**, **rock, rubber** and **cotton.** Wood, water, rock, rubber and cotton are **natural materials**. Paper, glass, and plastic are **artificial** (**man-made**) materials. Materials have different **physical properties**, some materials are **hard** whilst others are **soft**, some can be described as **rough** whilst others are **smooth**, some are **dull** whereas others are **shiny**. Materials can be grouped in a number of ways based on their physical properties. The material that we choose to make an object from depends on its purpose (e.g. no chocolate kettle). **Disciplinary knowledge:** ***Sort materials into a Carroll diagram based on their characteristics*** A&P: Scientists group objects or living things based on their properties.		and **omnivores**) based the foods they eat. Animals have different features, including **fins**, **wings**, **scales**, **legs**, **feathers**, **claws**, **paws** etc. Some animals can be grouped into **fish**, **amphibians, reptiles**, **birds** and **mammals** (name common examples). **Disciplinary knowledge:** A&P: Scientists conduct secondary research to learn from what other scientists have already learned. R&P: Use a Venn diagram to classify items into two or three sets based on properties. **Vertical Concepts:** 10: There are lots of types of animal, and some types can be grouped as amphibians, birds, fish, mammals and reptiles.	nose, mouth, arms, shoulders, elbows, hands, fingers, legs, knees, feet, toes, face. Humans have five **senses**, smell, taste, touch, sight and hearing. The five senses are each associated with different body parts (eyes, ears, nose, tongue). **Disciplinary knowledge:** ***Draw a scientific diagram, labelling key human body parts*** **Vertical Concepts:** 8: Living things, including humans, react to their surroundings with their senses. 11: Humans have five senses. Some people have impairments, like visual and hearing impairments.

		A&P: Scientists and geographers look for patterns in the world around them. R&P: Record numerical or descriptive observations in a table. ***Use information from images of four seasons to identify and record differences in wildlife and weather in four seasons*** M&O: Gather information from text/books/images. **Vertical Concepts:** 5B: The weather can change rapidly. The four different seasons have different weather patterns. 6: Daytime is when the Earth is facing the Sun; nighttime is when the Earth is facing away from the Sun.	R&P: Use a Carroll diagram to classify items based on properties. ***Find the best material for a dog bed (waterproof and soft)*** A&E: Make simple statements about the results of an enquiry. **Vertical Concepts:** 1: Objects have a purpose and are made of different materials.			
Year 2	**BIOLOGY** **Plant growth** Plants grow from seeds, and require water, light and a suitable temperature	**BIOLOGY** **Needs of animals** Animals need water, food and air to survive and to have offspring	**CHEMISTRY** **Uses of materials** Comparisons of an object's material with its use; impact of bending, twisting on solid objects	**BIOLOGY** **Living things & habitats** Introduction to habitats, micro-habitats, and simple food chains	**CHEMISTRY** **Solids, liquids and gases** How the same substances can exist as solids, liquids and gases	**Consolidation and review**
	Substantive knowledge: A seed is **living.** A seed is the **embryonic** stage of the plant life cycle. A seed consists of three parts: the **seed coat**, the **endosperm** and the **embryo.**	**Substantive knowledge:** A **natural resource** is a material or substance that is produced by the **environment** (not man made) and may be used to support life.	**Substantive knowledge:** **Matter** is all the 'stuff' that we experience in everyday life, including air, water, tables and us! Materials have different **physical properties** such as **malleable**,	**Substantive knowledge:** Everything in the world can be categorised as either **alive**, used to be alive or has never been alive.	**Substantive knowledge:** All **materials** are made of a single **substance** or a **mixture** of **substances.** **Matter** is what all 'stuff' is made from.	

	Germination is the development of a plant from a **seed**. During germination, **roots** and **shoots** emerge and grow. To **germinate,** a seed needs water and a certain temperature. **Temperature** is a measure of how hot or cold something is. Some plants grow from **bulbs**. A bulb is a resting stage for certain plants. They have a large underground food store, short **stems** and fleshy leaves. When a plant grows it gets bigger. Plants need **water**, **light** and a suitable **temperature** to grow. Many plants make **fruits** or **vegetables**; some of these grow below ground. **Disciplinary knowledge:** ***Investigate the conditions required for germination*** A&P: Make a prediction based on substantive knowledge. A&P: It is important that we keep as much as we can the same, apart from the thing we measure and the one thing we change. ***Investigate how light affects the growth of plants***	Food and water are natural resources. Animals, including humans, need **food** to survive. Humans need to eat a healthy and **balanced diet**. This should include all the **nutrients** that we need, should be high in fruits and vegetables and low in fats, salt and sugars. Animals, including humans, need **water** and **oxygen** to survive. Animals, including humans, the **right temperature** to survive. Animals, including humans, **reproduce**. This means they have **offspring** that grow into adults. As animals **grow,** they get bigger. Some animals change **form** as they get older (e.g. tadpole to frog). Humans need **exercise** to stay healthy. Humans need to practise **hygiene** to stay healthy. **Disciplinary knowledge:** ***Gather information from images and/or text and group animals into those that change form as they grow and those that do not*** ***Gather information from images and/or text and group animals into those that change***	**waterproof**, **heatproof**, **windproof** and **absorbent**. These physical properties make the materials more suitable for certain uses. Everyday materials such as **wood**, **metal**, **plastic**, **brick**, **rock**, **paper** and **cardboard** have these physical properties but to different extents. Different combinations of materials can be used to create different objects, for example a saucepan or a mop. The shape of some solid objects made from some materials can be changed by **squashing**, **bending**, **twisting** or **stretching** the material. **Sustainability** means meeting the needs of the people today, whilst meeting the needs of people of the future. One way to use materials more sustainably is to **reduce**, **reuse** and **recycle** wherever possible. **Disciplinary knowledge:** ***Classify materials based on the extent of its properties by using a pair of axes*** R&P: Use a pair of axes to classify items based on	Living things are called **organisms.** Organisms **m**ove, **r**eproduce, are **s**ensitive to their **s**urroundings, **g**row, need **o**xygen, get rid of their **w**aste, and need **n**utrition (MRS GOWN). Animals move from place to place, while plants move on the spot. **Habitats** are the places that living things live. A very small habitat is called a **micro-habitat**, and these can be found within larger habitats. **Flora** describes plant life; **fauna** describes animal life. A **species** is a group of living things that are the same type. **Biodiversity** is a word we use to describe all of the living things in an area. Animals and plants in a habitat depend on each other, e.g. for food or shelter. Animals get their food from plants and other animals. This food provides the **energy** animals need. Most plants produce their own food and are called **producers**.	There are three **states of matter**: **solids**, **liquids** and **gases.** Substances can exist as solids, liquids and gases. The three states of matter have different properties. Liquids take the shape of the container they are in, when you move the liquid into a different container the shape will change. Solids keep their shape unless a force is put on it. They will change their shape if you cut them or squash them. Gases have no fixed shape or volume, they spread out to fill a container. If they are not in a container, they will keep spreading out. We can decide if a substance is in its solid, liquid or gaseous state by looking at its properties. One substance can exist in the different states, when the substance is in a different state it is still the same substance. The Earth is getting warmer. We call this **global warming**. Global warming will cause	

	M&O: Make systematic observations of an object.	**Vertical Concepts:** 5B: The air is all around us on Earth. Air has oxygen in it. 8: All living things need food, oxygen, water and certain temperature conditions. 9: Plants and animals reproduce (have offspring). 11: Humans need to exercise, practise good hygiene and eat a healthy and balanced diet to stay healthy. Their diet should be high in fruits and vegetables and low in fats, sugar and salt.	the extent to which it displays two properties. ***Investigate the best material to use to make an umbrella that is waterproof and windproof*** A&P: There are four main stages of enquiry (A&P, M&O, R&P, A&E). A&P: Scientists identify potential hazards in their experiments and plan ways to reduce them. A&E: Ask further questions that could be explored to extend findings. **Vertical Concepts:** 1: All the 'stuff' encountered in everyday life, including air, water and different kinds of solid substances, is called matter. Different materials are recognisable by their properties. Materials have different properties, which make them suitable for specific purposes. 2: We can move or change the shape of objects by pushing and pulling: by squashing, bending, twisting or stretching the materials.	In a **food chain**, the arrows show where the **energy** is being transferred from and to. Living things are **adapted** to their **environment**. This means they may not be able to survive in other habitats. Some animals and plants are adapted to life in a **hot desert**: **camels** and **cacti.** Some animals and plants are adapted to life in a **cold desert**: **Arctic fox, polar bear, penguin** and **shrubs.** **Disciplinary knowledge:** ***Examine microhabitats using a magnifying glass and counting the number and type of organisms found in an area*** M&O: Observe using a magnifying glass safely. **Vertical Concepts:** 4: All living things need food to give them energy. All food chains start with a producer (a living thing that makes its own food). The arrows in a food chain show where energy is being transferred from and to.	solid ice to melt and become liquid water. **Disciplinary knowledge:** ***Classify different substances as solids, liquids or gases.*** **Vertical Concepts:** 1: Matter can exist in three different states: as solids, liquids and gases. The amount and type of substance does not change when the matter changes state. 5B: Global warming describes the increase in Earth's average temperatures.	

				8: Most plants make their own food. Animals' food comes from eating plants (herbivores) or by eating animals (carnivores), which have eaten plants or other animals. These relationships can be represented in a food chain. Plants and animals are often dependent on each other. Organisms are adapted to their environment. If conditions in a habitat change, organisms may not be able to survive. Organisms move, reproduce, are sensitive to surroundings, grow, need oxygen, get rid of waste, and need nutrition (MRS GOWN). 9: A species is a group of living things of the same type. 10: Biodiversity describes all the different living things in an area. Living things are adapted to their environments. If the environment changes, the organisms may no longer be adapted and may struggle to survive.		

Year 3	**CHEMISTRY** **Rocks** Comparisons of types of rocks and how fossils are formed	**PHYSICS** **Light** Relationship between light and how we see; the formation of shadows	**BIOLOGY** **Organisms** The role of muscles and skeletons; the importance of nutrients	**BIOLOGY** **Plants** Features of flowering plants and what they need to survive	**PHYSICS** **Forces & motion** Introducing pushes and pulls; opposing forces, and balanced forces	**PHYSICS** **Magnetism** Contact and non-contact forces, including friction and magnetism
	Substantive knowledge: A rock is a naturally occurring material which is made up of different minerals. The Earth's crust is it's the outermost layer of our planet. It is made of rocks and minerals. Natural rocks are either **igneous**, **sedimentary** or **metamorphic.** Man-made rocks, like concrete, are called **anthropic** rocks. **Igneous** rock is formed when **magma** or **lava** cools down. **Sedimentary** rock is formed when layers of small **sediments** are **compressed** over a long period of time. Igneous rock can become sedimentary rock if it breaks down into small pieces and forms layers. **Metamorphic** rock is formed when igneous or sedimentary rock is put under lots of **pressure.** Different rocks have different properties, including **permeable /impermeable.**	**Substantive knowledge:** **Light** travels in straight lines. We see when light enters our eyes. **Darkness** is the absence of light. **Sources** of light **emit** their own light, and others **reflect** light; both occur in nature as well as man-made objects. Some materials are more **reflective** than others. **Opaque**, **translucent** and **transparent** materials allow no, some or all light to pass through them. **Shadows** form behind an opaque object when light from a source is blocked. The shape and position of shadows changes with the angle of the light source. The size of shadows changes when the distance of the light source changes. Light from the Sun can be dangerous and there are ways to protect our eyes and skin. **Disciplinary knowledge:** ***Investigate how the height of a shadow varies as the***	**Substantive knowledge:** The main food groups are **carbohydrates** (**starch** and **sugars**), **proteins**, **fats**, **fibre**, **vitamins and minerals.** Humans need a **balanced diet** which is made of main food groups. **Plant-based** diets can be balanced. Eating foods that are in season can reduce **food waste**. **Vitamins**, **minerals** and **fibre** are needed and being deficient in these causes **diseases.** Different animals have different **nutritional** needs. Our **skeleton** is made up of bones that grow as we grow. Humans and some other animals have skeletons. **Organs** are parts of the body that do a particular job, the **heart** pumps blood around the body and the **lungs** are used for breathing which gets air into your body. The skeleton **protects** organs, e.g. the skull	**Substantive knowledge:** **Oxygen** and **carbon dioxide** are found in the air. Plants need air (oxygen and carbon dioxide), water, light, nutrients from the soil, space, and a suitable temperature to grow. Requirements for life vary from plant to plant and they are adapted to their **environment**. **Roots** absorb **nutrients** from the soil and help anchor the plant. The **stem/trunk** supports the plant and transports water up the plant. The **xylem** transports water and nutrients from the roots, and the **phloem** transports food from the leaves to the all parts of the plant. Leaves use sunlight, carbon dioxide from the air and water to make their own food. The four main stages of the plant's life cycle include **germination**,	**Substantive knowledge:** **Forces** are **pushes** or **pulls.** Forces arise when objects interact with each other. Forces can cause a change in speed, direction or shape of an object. Forces act in particular **directions.** We use arrows to show the size of the force and the direction it acts in. Forces that act in opposite directions are called **opposing forces**. Forces that act in opposite directions and are equal are described as **balanced forces**. When forces are balanced, there is no change in the speed, direction or shape of an object. Forces that act in opposite directions and are not equal are described as **unbalanced forces**. When forces are unbalanced, there is a	**Substantive knowledge:** **Contact** forces require contact between two objects (e.g. friction). **Non-contact** forces can affect an object at a distance (e.g. magnetism). Friction is a contact force because it requires the two objects to be touching. **Magnetism** is the force exerted by magnets when they attract or repel each other. Magnets can exert a force at a distance, so is a non-contact force. Magnets have a **north** and a **south pole**. If opposite poles are facing, the magnets will be **attracted** to one another (the magnets pull towards each other). If the same poles are facing, the magnets will **repel** (the magnets will push away from each other).

	A **fossil** is physical evidence of an ancient plant or animal; this could be their **preserved** remains or other **traces** that they made when they were alive. **Trace fossils** are not physical remains of organisms; they are indirect evidence of life. Examples include imprints of, or marks left by, an organism, such as a footprint, imprint of a feather or poo. Fossils can be formed when an organism or trace is buried under sediment. The remains break down slowly and, as layers of sediment build up, the layers are squashed, turning them into sedimentary rock. Fossils can also form when dead organisms are frozen in ice or preserved in amber. **Megafauna** are very large animals. Fossils provide evidence for megafauna that are extinct. When there are no living individuals of a species, that species is **extinct**. **Soil** is a mixture of tiny pieces of rock, dead plants and animals, air and water. Different soils have different properties.	***distance between light source and object changes*** A&P: A dependent variable is what you measure; an independent variable is what you change; controlled variables are things that stay the same. A&P: Scientists identify factors in an investigation that should be controlled, and try to find ways to control them. A&P: Recognise risk and build a plan to minimise them. A&P: Select most appropriate equipment to measure (the variables). A&P: Write an appropriate method. 2: Objects can affect other objects even when they are not in contact with them. Light reaches our eyes, even though the light source may be far away. 6: The Sun emits light, some of which reaches Earth. The Moon reflects light from the Sun.	protects the brain; and the ribcage protects the lungs, heart and other important organs. The skeleton **supports** the body, e.g. the spine helps the body stand. The skeleton **helps the body move**, e.g. pelvis and knee joints. The **muscles** and skeleton are required to help the body move. When muscles **contract** they pull the bone. Some organisms have **endoskeletons**, some have **exoskeletons**, and some have neither. Endoskeletons grow with the organism. Exoskeletons do not grow, so need to be shed and replaced. Science is studied as three disciplines: biology (study of organisms), chemistry (study of materials) and physics (study of energy). **Disciplinary knowledge:** ***Label the main bones on a diagram of a human skeleton, give the function of each bone.*** **Vertical Concepts:** 7: Humans are organised with organs like hearts and lungs, which do	**pollination**, **fertilisation** and **seed dispersal.** **Coniferous** trees transport their seeds in cones; **deciduous** trees us e seeds and flowers /fruit. **Pollination** and **fertilisation** usually takes place in flowers. Dispersal is important to make sure there is enough space for seeds to germinate and plants to grow. **Pollinators** like bees and other insects, bats and hummingbirds are vital for the reproduction of many plants. Seeds can be dispersed by wind (e.g. sycamore), by animals in their droppings (e.g. things that are eaten, like a raspberry), attached to animal fur (e.g. goosegrass), or seeds can be **self-propelled** (pea pod). **Disciplinary knowledge:** ***Investigate the impact of light on the growth of plants, drawing a block diagram to illustrate results*** R&P: Design a table to collect data with the	change in the speed, direction and/or shape of an object. **Friction** is a force between two surfaces that are sliding or trying to slide over each other. The bumpier or rougher the surfaces, the more friction there will be. **Disciplinary knowledge:** ***Investigate how the surface of a ramp affects the distance a car will travel*** M&O: Taking multiple readings allows you to see if your data is repeatable and helps you identify anomalous results. Anomalous results should be discarded and re-recorded. M&O: Data is repeatable if the same person repeats the investigation and gets the same results; data is reproducible if the investigation is repeated by a different person and the results are the same. A&E: Draw conclusions (e.g. 'the greater the… , the greater the…'). **Vertical Concepts:**	Magnets attract objects made from magnetic materials. Some metals are magnetic but not all are. Plastics, wood, fabric, glass are all non-magnetic. The closer to the poles of the magnet, the stronger the magnetic force. Magnetic forces act at a distance (non-contact force) and can act through materials. A stronger magnet can attract an object through thicker layer of material compared to a weaker magnet. The stronger the magnet, the heavier the object it can attract. **Disciplinary knowledge:** ***Test which materials are magnetic, and use this knowledge to make predictions about which objects will be magnetic.*** A&E: Use findings of an investigation to make further predictions. A&E: Suggest ways to improve practical procedures to obtain

	Disciplinary knowledge: ***Make observations about rocks using senses and magnifying glass, and classify them in a Carroll diagram/pair of axes*** **Vertical Concepts:** 5A: Rocks are formed when placed under pressure. Much of the solid surface of the Earth is covered in soil, which is a mixture of pieces of rock of various sizes and the remains of organisms. Some soil also contains air, water and some nutrients. There are three main kinds of rock: igneous, sedimentary and metamorphic, which each have different composition and properties. 9: When there are no living individuals of a species to reproduce, the species is extinct. 10: We know about extinct and dead species from fossils. These are the preserved remains (or traces) of organisms that lived many years ago.		particular jobs. The skeleton and muscles allow the body to move. 10: To help scientists make sense of the diversity of organisms, they are classified into different groups. Each group has similar features. 11: A balanced diet includes the right proportions of the main food groups of carbohydrates (starch and sugars), proteins, fats, fibre, vitamins and minerals. Animals, including humans, may get diseases (like scurvy) if they are deficient in vitamins and minerals.	appropriate number of rows and columns and correct headings. ***Research methods of seed dispersal of different plants*** M&O: Gather information from the internet. **Vertical Concepts:** 4: In most plants, sunlight, carbon dioxide and water are used to make food in the leaves. 5B: Air has carbon dioxide in it. 8: Plants make their own food using sunlight, carbon dioxide and water. 9: When a plant reproduces, it goes through stages of pollination, fertilisation and seed dispersal. The seed will then germinate and grow into a plant.	3: Forces act in pairs. Forces acting against each other are opposing. If opposing forces equal, they are balanced, and the object's motion will stay the same; this includes staying stationary. If opposing forces are unequal, they are unbalanced will change an object's speed, direction or shape. Friction is a force that will slow an object down.	more accurate measurements. **Vertical Concepts:** 2: The non-contact force of magnetism mean magnets can attract or repel other magnets and attract objects made of magnetic materials. 3: Friction is an example of a contact force.
Year 4	**BIOLOGY** **Classifying organisms** Introduction to classifying animals and their environment	**BIOLOGY** **Food & digestion** The human digestive system and food relationships in ecosystems	**CHEMISTRY** **Particle model and states of matter** States of matter in relation to particle arrangement	**PHYSICS** **Sounds** Relationship between strength of vibrations and volume of sound	**PHYSICS** **Electricity** Simple series circuits	**CHEMISTRY** **Properties of materials** Considering physical and chemical properties

	Substantive knowledge: **Classification** refers to a method used to place all living things into groups. **Organisms** can be classified in a number of ways. Fish, amphibians, reptiles, birds and mammals are all **vertebrates**. Vertebrates have **endoskeletons.** Vertebrates can be grouped in a number of ways based on their characteristics, e.g. **warm/cold blooded**; or physical features like fur, beak, wings etc. **Invertebrates** can be grouped based on their characteristics as **snails** and **slugs**; **worms**; **spiders** and **insects.** Invertebrates can be placed into groups based on their skeletons; **endoskeletons**, **exoskeletons**, or **hydrostatic skeletons.** Plants can be grouped into **flowering** and **non-flowering** plants. A **species** is a group of one type of organism. Individuals in this group can breed with each other to produce **offspring** that can go on to **reproduce.** Protecting biodiversity is important as the different	**Substantive knowledge:** A food chain starts with a **producer** (usually a plant) who can produce its own food. Organisms that eat producers are called **consumers** (primary and secondary). A **predator** hunts **prey** to eat. A **food web** shows the transfer of energy between different organisms (include water as well as land organisms). An **ecosystem** is made up of all organisms living in an area and the non-living features of the environment. There are four main types of teeth: **incisors**, **canines**, **pre-molars** and **molars**. They each have a different purpose. **Herbivores**, **carnivores** and **omnivores** have teeth types in different proportions. Babies' teeth develop before they are born, **deciduous** (milk) teeth push through the gums when a child is about 6 months. **Deciduous** teeth fall out from the age of 5 and are replaced with adult teeth. Bacteria can cause tooth decay.	**Substantive knowledge:** The different **substances** in their different forms (solids, liquids and gases) are all made of **particles.** The **particles** in the different states of matter are arranged differently. In solids, the particles are packed tightly together, they vibrate slowly, and are unable to move away from their neighbours. In liquids, the particles are close together but can slide past each other. In gases, the particles are spread out and can move freely. Substances can change from one state of matter to another. The process that changes a substance from solid to a liquid is called **melting**. The process that changes a substance from liquid to a gas is called **evaporation**. Evaporation is different from boiling. The process that changes a gaseous substance to liquid is called **condensation**. The process that changes a liquid substance to solid is called **freezing.** Substances change state at different temperatures.	**Substantive knowledge:** **Sounds** are made when objects **vibrate**. Sounds are transmitted from a source to a detector. Vibrations travel through a **medium** (e.g. air, water) to the ear. Vibrations enter the ear, our **inner ear** vibrates and we hear them as sound. Vibrations are passed on from one particle to the next, and so it travels more easily when particles are closer together (solids and liquids). Sound cannot travel in a **vacuum.** The **volume** of a sound is how loud or quiet it is. Louder sounds are caused by bigger vibrations, smaller sounds are caused by smaller vibrations. The **pitch** of a sound is how high or low it is. Sounds get fainter as the distance from the sound source increases. Different animals hear different sounds. Humans' hearing changes as we age.	**Substantive knowledge:** **Electrical appliances** have a purpose and require electricity to work (e.g. toaster, kettle, fan, phone, game). Electrical appliances should be switched off when not in use. A **lamp** in a **circuit** will only light if there is a **complete circuit**. A complete circuit must have at least one cell and have all the **components** connected in a loop. If it is missing any of these things it is an **incomplete circuit.** **Switches** complete or break a circuit. A **short circuit** can be created by accident by connecting just the wire to the cell in a circuit. They can be dangerous. Components include **wire**, **lamp**, **buzzer**, **motor** or **switch.** Materials that allow electricity to pass through them easily are called **electrical conductors.** Metals and water are good conductors of electricity. Materials that do not allow electricity to pass	**Substantive knowledge:** **Physical properties** are properties that we can measure or observe in the classroom. Physical properties include electrical conductivity; melting and boiling points; thermal conductivity; being malleable; windproof; hard/soft; and magnetic. Energy will be transferred from places with a higher temperature to places with a lower temperature. **Thermal conductors** allow energy to be transferred through them easily when they are heated. Metals are good thermal conductors. **Thermal insulators** do not allow energy to be transferred through them easily when heated. Thermal insulators include trapped air, plastic and wood. Elasticity is a physical property. Elastic materials can stretch and then return to its original form.

	species depend on each other to provide food, shelter and many other resources. This is called **interdependence**. Many things threaten biodiversity, including the loss of habitats (from global warming, building and extracting resources), agriculture, and hunting. **Disciplinary knowledge:** ***Exploring classification debates (e.g. duck-billed platypus)*** A&P: Identify scientific evidence that has been used to support or refute ideas. ***Use a classification key to sort organisms*** R&P: Use a classification key to identify an object. ***Draw a classification key to identify four animals, and then several leaves (using a magnifying glass)*** R&P: Draw a dichotomous classification key to help others identify an object. **Vertical Concepts:** 9: A species is a group of one type of organism. Individuals in this group can breed with each other to produce offspring that can go on to reproduce.	Animals and plants need to **digest** food to transfer energy from it. The **digestive** system is the group of organs that help your body digest food. Digestion in humans is **chemical** and **mechanical.** Chemical and mechanical digestion takes place in the mouth (saliva and chewing). Food travels down the **oesophagus** from the mouth into the **stomach.** In the **stomach**, mechanical (churning) and chemical digestion takes place to break down food further. Food is further broken down by enzymes (chemical digestion) in the **small intestines** where most of the nutrients are absorbed. Water is absorbed in the **large intestine**, leaving behind the **faeces**. **Faeces** are mainly made of food we could not digest; faeces are stored in the **rectum** and pass out of the human body via the **anus.** **Disciplinary knowledge:** ***Explain the digestion process using a prop to others in school or at home*** R&P: Present information orally using a prop or demonstration.	Different substances are different states at **room temperature.** The **water cycle** relies on **evaporation** and **condensation**. Water is collected in the oceans from rivers; it evaporates and then condenses to form clouds; it then **precipitates,** and the cycle begins again. **Disciplinary knowledge:** ***Investigate the effect of temperature on the rate of evaporation*** A&P: Set a hypothesis to test. A&E: Scientists use models to help explain their ideas. **Vertical Concepts:** 1: If a material could be divided into smaller and smaller pieces, it would be found to be made of particles, which smaller than can be seen even with a microscope. These particles are not in a material; they are the material. The particles of a substance are arranged differently when it is solid, liquid or gas. 5B: The water cycle involves evaporation of water from oceans and condensation of water,	**Disciplinary knowledge:** ***Investigate the tautness on pitch using an app*** M&O: Gather information using a data logger (e.g. sound meter app; heart rate app). **Vertical Concepts:** 2: Sound comes from objects that vibrate and can be detected at a distance from the source, because the air or other material around is made to vibrate. Sounds are heard when the vibrations in the air reach our ears. 11: Humans with hearing loss may use closed captions, hearing aids and/or sign language.	through them easily are called **electrical insulators.** Plastic, rubber, wood, glass, paper and fabric are electrical insulators **Disciplinary knowledge:** ***Investigate which materials are electrical conductors and which are electrical insulators*** A&P: Draw diagram of the investigation. R&P: Present information in a written format. **Vertical Concepts:** 4: A cell in a complete circuit can make a bulb light or buzzer sound. This will not happen without a cell.	**Chemical properties** are properties that scientists need specialist equipment to measure. Chemical properties include how easy a substance is to set on fire (**flammability**) or how poisonous something is (**toxicity**). As we learn more about a substance's properties, we may decide to stop using it to make certain objects (e.g. lead in pencils is toxic; asbestos is a good insulator but is toxic. **Disciplinary knowledge:** ***Investigating the physical properties (thermal conductivity; malleability; transparency; magnetism; electrical conductivity etc.) of materials, using own knowledge or setting up comparative tests.*** ***Conduct secondary research to identify an object that was once made of one material but, when new evidence showed other chemical or physical properties, are now***

		R&P: Drawings can be **labelled** and **annotated**. **Vertical Concepts:** 4 & 8: The arrows in a food web show where energy is being transferred from and to. 11: Bacteria are tiny living things. Some are useful for humans, and some can cause diseases. Bacteria can cause tooth decay.	which falls as precipitation.			***made of new materials (e.g. asbestos insulation; lead pencils; plastic bottles).*** **Vertical Concepts:** 1: Properties of materials can be physical (such as hardness) or chemical (such as toxicity). 11: Some substances are toxic; this means they can be poisonous. Humans and other organisms need to avoid these to stay healthy.
Year 5	**CHEMISTRY** **Separating mixtures** Identifying and separating mixtures; reversible and non-reversible changes	**BIO / CHEM / PHYSICS** **Energy** Introducing the concept of energy stores and energy transfers; relate this to prior knowledge	**BIOLOGY** **Life cycles** Life cycles of a mammal, amphibian, insect, bird, and some reproduction processes	**BIOLOGY** **Human development** Human development to old age	**BIOLOGY** **Human development** Human development to old age	**PHYSICS** **Earth and space** Movements of planets and the Moon, and relationship to day and night
	Substantive knowledge: A **pure substance** is one that contains only one type of particle. A **mixture** is two or more different substances, e.g. air, steel. **Mixtures** can be made of two gases (e.g. air), two solids (e.g. steel), two liquids (e.g. squash and water), or a liquid and a solid (e.g. salt water). A **solution** is made when one substance **dissolves** in another substance called a	**Substantive knowledge:** **Energy** is needed by both living and nonliving things. Energy can be **transferred** from one **store** to another store. When energy is removed from one store and is transferred to another store, the amount of energy in the first store goes down and the amount of energy in the second store goes up.	**Substantive knowledge:** A cell is the smallest building block of living things. All organisms are made of cells. There are lots of different types of cell, which each have different purposes. Plants and animals look similar to their parents in many features because information is passed from one **generation** to the next. This	**Substantive knowledge:** The human life cycle goes through the same stages as those for other animals: **fertilisation**, **gestation**, **growth.** Fertilisation in most humans is internal, but it can happen externally (**in vitro fertilisation** - IVF - which means 'in glass' fertilisation). The human life cycle: **embryo**, **foetus**, **infant**,	**Substantive knowledge:** **Force** is measured in **newtons** (N). **Gravity** is a **non-contact force** that pulls all objects towards each other. The greater the **mass** of the object, the greater the **gravitational pull** around it. Gravity is most commonly experienced as the pull of the Earth (and all	**Substantive knowledge:** The **universe** is made up of many **galaxies**. Our galaxy is called the **Milky Way.** The **Milky Way** is made up of lots of **solar systems.** Our solar system consists of a **star** (**Sun**), **planets** (which **orbit** a star), **satellites** (which orbit **planets**), and other bodies including **asteroids**, **meteoroids**,

	solvent. A solution is a mixture; it is made of more than one type of particle. The substance that dissolves is called the **solute**. The substance that it dissolves in is called the **solvent**. A substance that will dissolve in a solvent is **soluble** in that solvent. If it does not dissolve, it is **insoluble** in that substance. When no more solute can dissolve in the solvent, the solution is **saturated.** The higher the temperature of the solvent, the greater the mass of solute that can be dissolved. Two solids can be separated by using **magnets** or **filters** (e.g. sieve). A solid and a liquid can be separated by using **filtration** (if the solid is insoluble) or **evaporation** (if the solid is soluble). A **reversible** change is a change that can be undone, where the original substances can be recovered. An **irreversible** change is a change that cannot be undone, where the original substances cannot be recovered.	Energy is not used up; it is just moved around from store to store. **Energy stores** are needed for something to happen. **Energy resources** such as oil, gas, coal, food and other fuels can be depleted. Fossil fuels and batteries are examples of **chemical energy stores**. Energy can be stored **thermally** in the surroundings. Different foods (fuels) store more chemical energy per unit mass than others. The **Sun** is an example of a chemical energy store. In a **food chain,** an amount of energy from the Sun (a **chemical store**) is transferred to the plant by light. The energy is then transferred along the food chain as the different organisms are eaten. Not all the chemical energy stored in an organism is passed to the next organism in a food chain because a) not all of the organism is eaten and b) some energy is transferred from the organism to the thermal store of the surroundings. In a circuit that has a cell/battery, the	information comes from the parents' **genome**. **Sexual reproduction** involves two parents - usually male and female - creating a new **organism** by mixing their **genomes.** Sexual reproduction begins with **fertilisation** of an egg, which mixes the genes from two parents. Fertilisation can be internal or external. After an egg is fertilised, an embryo will develop. Embryos develop inside the body in the **gestation** period for **viviparous** animals. Embryos develop outside the body in eggs for **oviparous** animals. Viviparous animals are **born**, oviparous animals **hatch** from eggs, plant seeds **germinate.** Almost all mammals are viviparous; all birds and most amphibians are oviparous. Amphibians and most insects undergo **metamorphosis.** Life cycle of: hedgehog: internal fertilisation, gestation, hoglet, adult. peregrine falcon: internal fertilisation, incubation in eggs, hatchling, fledgling, adult.	**child**, **adolescent**, **adult**, **senior.** Human are **viviparous** and a **foetus** develops inside the mother (or **surrogate** mother). A human embryo is considered a foetus at the end of the 8th week of pregnancy. The **gestation** period for humans is 40 weeks. The bigger the animal, the longer the gestation period. A foetus is considered a baby when it is born. **Cognitive**, **physical** and **social** and **emotional** development takes place at the greatest rate during infancy. During **puberty**, adolescents' bodies change, e.g. pubic hair, voice deepen, hips widen. **Primary aging** of adults occurs naturally as our bodies get older (e.g. slower reaction time, reduced hearing). **Secondary ageing** relates to environmental factors, like poor diet, not enough exercise, smoking etc. There are ages where humans at their peak for different things (e.g.	objects on it) towards each other. The Earth's **gravitational pull** is so large that all objects - regardless of how heavy they are - are pulled towards Earth at the same rate. **Mass** is a measure of how much matter something is made from, which is measured in kg (or equivalent). The mass of an object is always the same. **Weight** is a force, it is measured in newtons (N). The weight of an object will differ depending on the force of gravity. **Air resistance** is a **frictional force** that acts between air and a moving object to slow it down. **Surface area** is the area that is facing the direction the object is travelling in. The larger the surface area of an object, the greater the air resistance. **Water resistance** is a frictional force that acts between water and a moving object to slow it down.	**meteors** and **meteorites.** The Sun is at the centre of the solar system - the **heliocentric model.** The sun, planets and **moons** are approximately **spherical** bodies. Planets orbit the Sun in the same **plane**; moons orbit planets. They are held in their orbits by **gravity**. The Earth takes 365.25 days to orbit the sun (one year). Every four years our Earth year is one day longer, this is called a **leap year**, this year accounts for the four 0.25 days. There are eight planets (M, V, E, M, J, S, U and N). Each planet has different characteristics, e.g. temperature; time taken to orbit the sun; number of moons; size. The Earth **rotates** on its **axis** once every 24 hours, so only half of the Earth is facing the Sun at any one time; this creates night and day. The Earth's rotation means that the sun

	Disciplinary knowledge: ***Investigate the effect of temperature on the mass of the solute that can be dissolved.*** ***Separate a mixture including coarse sand, water, salt and lumps of a magnetic material.*** **Vertical Concepts:** 1: A pure substance is one that contains only one type of particle. A mixture is created when two or more substances are mixed. The two types of particle are mixed together, but the particles themselves stay the same. 5B: Air is a mixture of lots of different gases, including oxygen and carbon dioxide.	cell/battery is the chemical store of energy. In a circuit, energy is transferred electrically to the device in the circuit, but the device does not store the energy; the device changes the way the energy is **transferred**. **Vertical Concepts:** 4: Many processes and phenomena are explained in terms of energy exchanges. Energy cannot be created or destroyed. When energy is transferred from one object to others, the total amount of energy in the universe remains the same; the amount that one object loses is the same as the other objects gain. Two examples of energy stores are thermal stores and chemical stores of energy. 8: Energy is transferred to the Earth by light. When making their own food, plants transfer some of this energy to their chemical store. As other organisms eat these producers, some energy in this chemical energy store is transferred.	frog: external fertilisation, frogspawn, tadpole, adult frog (metamorphosis). ladybird: internal fertilisation, eggs hatch, larva, pupa, adult. Most plants have both male and female parts. The male part of the plant is called the **stamen**, made up of the **anther** and **filament**, and the anther produces **pollen grains**. The female parts of the plant are the **ovary** (which produces the female sex cells which are contained in the **ovule**) and the **stigma** which collects pollen. **Asexual reproduction** does not involve sex cells or fertilisation. Only one parent is needed and offspring are (**genetically**) identical to the parent and each other. Potatoes develop **tubers** and daffodils have **bulbs**, which will grow to be identical copies of the plant. **Disciplinary knowledge:** ***Using images, text and the internet to research internal and external fertilisation, and***	reproduction, running etc.). Different cultures around the world have different perceptions around the life cycle and ageing. ***Draw a scatter graph to suggest whether there is a relationship between animal size and length of gestation period*** A&P: Scientists look for patterns in data to try to identify correlations. R&P: Scatter graphs can help you decide if there is a relationship between two variables. **Disciplinary knowledge:** ***Discuss one aspect of IVF that is appropriate to your class (e.g. who in the world has access; post code lottery within the UK)*** A&E: Some people may agree or disagree with the use of some scientific discoveries. **Vertical Concepts:** 11: Healthy development includes cognitive, physical, social and emotional development. Most of this happens during infancy and childhood.	**Levers**, **pulleys** and **gears** allow a smaller force to have a greater effect. Examples of levers, pulleys and gears include wheelbarrows, lifts, bicycle gears, in construction. Levers consist of a **beam** and a **fulcrum** (**pivot**). **Effort** lifts a **load.** The greater the distance from the effort to the fulcrum, the less effort is required to move the load. **Upthrust** is an upwards force that a liquid (and a gas) exerts on an object floating in it. If **upthrust** is equal to the weight of an object it will float. **Disciplinary knowledge:** ***Investigate how much force is required to pull objects over different surfaces*** M&O: Measure force using a Newtonmeter. ***Investigate how surface area affects air resistance, and how shape affects water resistance*** R&P: Line graphs can be used when data is continuous; bar charts	appears to 'rise' in the east and 'set' in the west. The Moon orbits the Earth in 28 days and, during this time, the sun shines on different parts of it. This creates phases of the Moon, including **new moon**, **crescent**, **quarter moon**, **gibbous moon** and **full moon.** Space is a **vacuum**, which means there are no particles. The Earth's Moon has less **mass,** so its **gravitational** force is less. **Geography:** Vertical lines called meridians split the Earth into 24 different time zones. **Geography:** Each time zone is x hours ahead or behind London, at the Prime Meridian. **Geography:** Some countries choose to operate in multiple time zones. **Disciplinary knowledge:** ***Look for patterns between a planet's distance from the Sun and its temperature and size.***

			viviparous and oviparous organisms **Vertical Concepts:** 7: A cell is the smallest building block of living things. All organisms are made of cells. There are lots of different types of cell (e.g. sex cells), which each have different purposes. 9: An organism's genome is the information that controls how that individual organism will develop. In sexual reproduction, two parents contribute to the formation of offspring. They each pass down half their genome through specialised cells called sex cells. The two halves are combined during fertilisation. While it inherits genetic information from both parents, the offspring's genome is distinct, which means the offspring is not identical to a parent. Asexual reproduction involves only one parent. In this process, the offspring's genome is an exact copy of the parent's genome. The offspring is identical to the parent.	Ageing happens naturally, and can be sped up by environmental factors like smoking. Some adults are unable to become pregnant. IVF and other treatments can be used.	can be used when data is discrete. A&E: Make judgements on the accuracy of the data. **Vertical Concepts:** 2: The non-contact force of gravity pulls objects towards the centre of the Earth. 3: There is gravitational force between all objects, but it is only felt when one or more of the objects has a very large mass. The greater the mass, the greater the gravitational force. Objects on Earth are pulled to the centre of the Earth because the Earth's mass and therefore gravitational force is much larger than that of the objects.	***Consider how the number of planets that humans consider to be planets has changed over time.*** A&E: Science is never 'complete' and scientists are always working to make models more accurate or to discover new explanations. **Vertical Concepts:** 3: The downward force of gravity on an object on the Moon is less than that on Earth because the Moon has less mass on Earth. 5B: There is less and less air further away from the Earth's surface; space is a vacuum. 6: Our Sun is one of many stars that make up the Universe. The distances between us and the bodies in solar system is huge, and even bigger in the Universe.

Year 6	**PHYSICS** **Electricity** Investigating variations in series and parallel circuits, and how electricity is generated	**PHYSICS** **Electricity** Investigating variations in series and parallel circuits, and how electricity is generated	**PHYSICS** **Light** How light travels and is reflected, and how this allows us to see	**BIOLOGY** **Further classification** Further classification of organisms based on characteristics	**BIOLOGY** **Functions of the human body** Human circulatory system; transport of nutrients within the body	**CHEMISTRY** **Physical and chemical changes** Identifying physical and chemical changes
	Substantive knowledge: There are recognised **symbols** for cell, lamp, buzzer, motor, and switch. Wires are represented with straight lines. As long as batteries have the same **voltage**, the size of the battery does not affect the brightness of the lamp/loudness of the buzzer (though the smaller batteries will not last as long as the larger ones). Adding more cells in the circuit increases the voltage. Increasing the voltage in a circuit makes the lamp in the circuit get brighter or the buzzer get louder. More than one lamp can be put into one circuit. They can be placed in **series** or in **parallel**. In a **series** circuit, the lamps are placed in a **continuous** loop. In **parallel**, the lamps are placed in separate loops that both connect to the cell.	**Substantive knowledge:** **Variation** occurs within and between **species.** Variation can be **environmental** or **genetic**, or a mixture of both. **Genetic** variation happens randomly through the mixing of **genomes** in **sexual reproduction**. Some variation is **advantageous** to the organism in their environment; sometimes it is **disadvantageous**; and sometimes it gives no advantage/disadvantage. An **organism** with **advantageous traits** are more likely to survive and reproduce, passing those traits to the next generation. This is called **natural selection.** These advantageous traits - **adaptations** - can be **physiological**, **structural** and **behavioural.** Over many generations, the species will **evolve** so that all organisms have this adaptation/advantageous trait.	**Substantive knowledge:** When light meets an opaque object, some of the light is reflected and some of it is absorbed. Shadows have the same shape as the objects that cast them because light travels in straight lines. The size and shape of shadows behind an **opaque** object can be explained using ray diagrams. Objects **emit** (give out) or **reflect** light into the eye. We see things because light travels from **light sources** to our eyes, or from light sources to objects and then to our eyes Objects would be invisible if they did not reflect light. The eye is made of many parts: the **pupil** is the circular black hole in the center of the eye, the **iris** is the coloured part of the eye that surrounds the pupil, and the **lens** is a	**Substantive knowledge:** **Invertebrates** can be grouped based on their characteristics as poriferans (sponges) cnidarians, echinoderms, molluscs, annelids, platyhelminths and arthropods. **Arthropods** can be grouped into 4 sub-groups: spiders, insects, crustaceans and myriapods). Plants can be grouped into moss, ferns, conifers and flowering plants. **Fungi** are different to plants and animals. They cannot make their own food (like animals) but do not move (like plants). **Micro-organisms** are organisms that are so small that we cannot see them with our eyes alone. Some **fungi** are microorganisms (e.g.	**Substantive knowledge:** Living things **m**ove, **r**eproduce, are **s**ensitive to their **s**urroundings, **g**row, respire, excrete, and need **n**utrition (MRS GREN). **Respiration** provides the energy needed for organisms to function. **Oxygen** and **glucose** (a sugar) are needed by **cells** for respiration. Carbon dioxide is a waste product of respiration and needs to be **excreted**. **Blood** carries **oxygen**, **glucose**, **nutrients,** and **carbon dioxide** to and from cells around the body. The **heart** is a muscle that pumps the blood through the **blood vessels**. The heart pumps **deoxygenated** blood to the lungs, where oxygen is transferred to it, and it flows back to	**Substantive knowledge:** A mixture is two or more substances that are mixed but not chemically joined together. Distillation is a separating technique that can separate a solvent from a solution. It relies on evaporation and condensation. Chromatography is a separation technique in which a mixture is dissolved into a solvent, and the components of the mixture are carried by the solvents at different rates. A chemical change is a change where a new substance is formed. A chemical change has usually taken place if: gas bubbles appear; a new solid appears; it changes colour; or changes temperature.

	Connecting lamps in parallel means that if one lamp burns out the other will stay on and switches can be used to turn each lamp off independently. Many of the **appliances** used in the home do not use batteries they use **mains electricity**. Mains electricity is **generated** in a **power station** and transferred to our homes by overhead cables. Power stations can use both **renewable** and **non-renewable** sources of energy to generate electricity. A **non-renewable energy resource** is one that is used much faster than it is created. Fossil fuels take millions of years to form but minutes to burn, so we will run out. Burning fossil fuels to transfer electrical energy is a non-renewable energy source. **Renewable energy resources** quickly replenish themselves, meaning that we can use them again and again and we will not run out. **Wind**, **solar**, **geothermal** and **hydrological** power are all examples of renewable energy resources. Coal, oil and gas are all used to generate	**Homo sapiens** originated in many parts of Africa. **Fossils** provide evidence for evolution, because they show how organisms have changed over time. Scientists involved in the development of evolutionary biology include Al-Jahiz, Charles Darwin, Alfred Wallace, Mary Anning and Dr Danielle Lee. **Disciplinary knowledge:** ***Sort variations within species in a Venn diagram, based on whether they are genetic, environmental or a mixture of both.*** ***Identify how evidence of fossils has been used to support to change the theory of the evolution of Homo sapiens.*** **Vertical Concepts:** 10: Variation exists within species, caused by genetic and environmental factors. Living things are found in certain environments because they have the features that enable them to survive there. This adaptation to their environment has come about because of the small differences that occur during reproduction, resulting in some	structure found behind the pupil. The pupils allow light to enter the eye. The iris controls how much light enters the eye by changing the size of the pupil. The lens helps to focus the light rays entering the eye. **White light**, which comes from most light sources we use in the classroom, contains all the colours of the **visible spectrum** (red, orange, yellow, green, blue, indigo, violet). When a light meets a surface, some colours are **absorbed** and some are **reflected**. We see the colour(s) that are reflected. Objects appear black if they absorb all the colours in white light and reflect none. Objects appear white if they reflect all the colours in white light, and absorb none. Many problems with our vision are caused by parts of the eye that are the not the right shape or size, or that have become cloudy. Many of these problems can be corrected through	yeast), but not all are (e.g. mushrooms). **Bacteria** and viruses are microorganisms. Some **bacteria** can cause disease in other organisms. Some bacteria are helpful for other organisms (e.g. those that help break down food in our digestive system) and those that form part of a **symbiotic relationship.** ***Use and draw classification keys to help classify invertebrates and plants*** ***Research the harmful effects that bacteria can have on humans and other organisms, and present this information in a written format.*** 7: Micro-organisms are organisms that are so small that we cannot see them with our eyes alone	the heart. The heart pumps **oxygenated** blood to the rest of the body, where the oxygen is transferred to the organs/muscles and carbon dioxide is transferred to the blood. Deoxygenated blood then travels back to the heart to begin the process again. **Glucose** and **nutrients** are absorbed by the blood along the **small intestine** and transported to cells. **Arteries** carry blood away from the heart. Arteries have thick walls because they carry blood from the heart which is at a high pressure. Blood is being pumped through very quickly. Arteries mostly carry oxygenated blood. **Veins** carry blood back to the heart. They mostly carry deoxygenated blood. Arteries branch into smaller blood vessels called **capillaries**, which are very small and supply our cells with oxygen, glucose and nutrients. Capillaries collect carbon dioxide	A physical change is where the substance changes its properties, but it does not become a different substance. Some chemical changes are irreversible, (e.g. cook an egg, rusting iron), but some can be reversed. Most physical changes are reversible (e.g. water to ice), but some are not (e.g. crack an egg, turn wood into sawdust). Chemical reactions can be summarised using word equations. Word equations show the names of the chemicals reacting and the names of the products formed. A combustion reaction occurs when a fuel is heated and reacts with oxygen. A product of a combustion reaction is carbon dioxide. Combustion is an irreversible chemical reaction. Rust is an irreversible chemical reaction. It requires iron, water and oxygen **Disciplinary knowledge:**

	electricity. The store of chemical energy in the fuel is transferred electrically to the appliances that we use in the home. **Disciplinary knowledge:** **Three different enquiries, where pupils will plan the most appropriate type of investigation and how they should present their results:** **Investigating the effect of increasing voltage on the volume of a buzzer or the brightness of a lamp** **Investigating the effect of changing the number of components in a circuit on the volume of a buzzer** R&P: Decide which graph is most appropriate for the enquiry. **Vertical Concepts:** 4: Energy resources can be renewable (such as wind, solar, geothermal and hydrological) or non-renewable (such as fossil fuels).	individuals being better suited to the environment than others. In the competition for materials and food, those that are better adapted will survive and are more likely to pass on their adapted feature to their offspring. Fossils are evidence of evolution.	surgery or **prescription** glasses. People living with sight loss or blindness may use long canes or guide dogs when outside, talking books or **Braille**, and different devices in the home. On a flat surface, all light meeting a surface from one direction will be reflected in the same direction. This is known as **specular reflection.** On a rough surface, light will be reflected in all directions. This is known as **diffuse reflection.** Specular reflection between mirrors allow us to see the objects that do not directly reflect light into our eyes (e.g. periscope). **Disciplinary knowledge:** ***Draw ray diagrams to show how light travels and how shadows are formed*** **Vertical Concepts:** 11: Visual impairments include long and short sightedness, colour vision deficiency, and blindness. Some of these can be corrected, and some people with visual impairments will use Braille, magnifying		from cells and merge into veins. The **heart rate** is how quickly the heart pumps. It is usually measured in beats/min. Muscles need more oxygen when they are being used in exercise, so the heart rate increases. Being **healthy** means being in a state of **physical**, **mental** and **social** wellbeing and free from disease. Diet and exercise can have a positive effect on our bodies. Other lifestyle choices impact our health. A **drug** is a substance that, when taken into the body, has an effect on it. Some drugs (**medicines**) are helpful, and some are only harmful. All drugs are harmful when taken in the wrong quantities. Tobacco smoke contains nicotine, tar and carbon monoxide. These have a damaging effect on the body. **Disciplinary knowledge:** ***Investigate the effect of exercise on heart rate***	***Use a Carroll diagram to classify changes as physical/chemical and reversible/irreversible*** ***Carry out changes and identify whether the change created is physical/chemical and reversible/irreversible*** A chemical change is where a new substance – that is made of a different type of particle – is formed.

			devices, canes and/or guide dogs.		M&O: Planning to take multiple readings allows anomalous data to be identified and enables a mean to be calculated. Repeats show if our data is repeatable. A&E: Calculating the mean can be used as a method of analysing data. ***Research effects of smoking on the human body, and how our scientific understanding has changed over time, including in the current day.*** **Vertical Concepts:** 4: All organisms respire. 7: Respiration takes place in cells. 8: Living things move, reproduce, are sensitive to their surroundings, grow, respire, excrete, and need nutrition (MRS GREN). 11: Being healthy means we are in a state of physical, mental and social wellbeing and are free from disease. Some drugs can help us and some can harm us (particularly in the wrong quantities).	